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ABSTRACT

The goal of the research and development project described is to make it possible for students in grades K-8 to acquire at least minimal computer-related skills. The report gives the long range goals of the project, perceptions on the need for a computer literacy program, recommendations of approaches for satisfying that need, and the pros and cons of a K-8 infusion approach to computer literacy. A series of curriculum guides for the K-8 computer literacy program for use by school administrators, media center people, teachers for grades K-8, and subject coordinators will be produced before the termination of the project, scheduled for September 1983. (MER)

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An Approach to Integrating Computer Literacy Into the K-8 Curriculum

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PREFATORY NOTE

This paper is based on a presentation for the National Educational Computer Conference, Norfolk, Va., June 24, 1980. It describes a project being conducted by HumRRO under a grant from the National Science Foundation (SED-7923684).

Results of this project will enable schools to infuse computer-related skills and knowledges into the traditional curricula of elementary and junior high school science, social studies, and mathematics courses. The goal of this Project is to help make it possible for all students—kindergarten through junior high—to acquire at least the minimal computer-related skills they will need for their continuing education and for their role as citizens in our information-based society.

Research and development activities in Project COMPUTER-LIT began in April 1980 and are scheduled for completion in September 1983. Mrs. Beverly Hunter, author of this paper, is Project Director.

OCT 2 8 1980

AN APPROACH TO INTEGRATING COMPUTER LITERACY INTO THE K-8 CURRICULUM[1]

Beverly Hunter
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This paper describes an approach to integrating computer literacy into grades K-8, and the reasons for that approach. A key idea in the approach is "a modesty of aims," because of discrepancies between computer literacy needs, existing curricula, and learning resources.

Computer literacy may be defined as, "whatever a person needs to know and do with computers in order to function competently in our information-based society." This definition highlights the fact that specific skills, knowledge, and values required will vary from person to person, from job to job, and from time to time. Specialized knowledge required for a career as a computer designer, programmer, technician, or analyst is usually excluded from the computer literacy domain. Content areas often included in "computer literacy" are summarized below.

- Impact of computing on society, my work, my institution
- Applications in various fields
- Programming and problem solving
- Hardware/software/systems
- Awareness of careers
- Personal tool for learning and working
- Control over machines, systems
- Ethical, responsible behavior ← → information systems

Long Range Goals

Eventually, students and teachers will have many tools of our information-based society available to them as a normal part of their work and study. Information retrieval, data analysis, computation aids, simulations, word processing, drills, tutorials, dialogues, various high-level programming languages—these and other computer applications will be a normal part of a person's repertoire of resources for learning and thinking. Use of such resources will stimulate changes in curricula. Students will be expected to be more productive than they are now, and to deal with more complex phenomena.

As they learn to use these tools in their studies, students should be taught such things as dangers of inappropriate dependence on machines, sources of errors in systems and programs, appropriate and inappropriate uses of information systems, ethics of information use and misuse. A summary of purposes for a K-8 computer literacy program is shown as Figure 1.

[1] Based on a presentation for National Educational Computer Conference, June 24, 1980. This work is supported by the National Science Foundation Development in Science Education (DISE), Grant No. SED79-23684.

- Help students and teachers to value computers as general purpose machines designed, built and operated by humans to assist in many tasks.
- Encourage teachers and students to find and create computer applications that are useful to them in teaching, learning, managing information and solving problems in math, science and social studies.
- Help students and teachers to develop a sense of control over computers and to learn a variety of tools and techniques for exercising that control.
- Help students and teachers learn to use computers as an aid in solving problems. This should have the side-effect of increasing the emphasis on problem solving in the classroom and increasing the variety of problems addressed.
- Encourage teachers and students to behave in an ethical and responsible manner in relation to the computers and information systems they use.
- Help students and teachers to become aware of a variety of computer applications and their uses by individuals and organizations.
- Help students and teachers learn to evaluate advantages, disadvantages and limitations of particular computer applications.
- Help teachers and students to become aware of ways computers affect groups and individuals, thereby helping to prepare students for responsible citizenship.
- Help students and teachers become aware of computer-related skills and experience that are important in a variety of careers.

Figure 1. **Purposes of a Computer Literacy Program for Grades K-8**

Diverse Perceptions of the Need

Awareness of the need for computer literacy for citizens, workers, and school children is now spreading very rapidly. Ten years ago, only a handful of educators used the phrase "computer literacy." Conferences on educational computing didn't have a category for papers or panels on the subject. When the idea was discussed, it was usually with regard to college students, scientists, or managers.

Various reasons for the computer literacy need are:

- Information-based society: discontinuity in educational needs.
- Technological competition: need to increase productivity of U.S.
- Equity of educational opportunity.
- Computer an indispensable tool—science, business, government.
- Need to take control over machines.
- Computers, calculators make some subjects obsolete.
- Need to learn tools for dealing with complex phenomena.
- Most careers are computer related.

Educational equity is a key reason for addressing computer literacy in the K-8 grades. If you want to reach all students, you have to do it before they start making critical choices in high school about their electives.

Equity is extremely important because of the rapidly developing gap between the haves and have-nots in this society, where access to information and the intellectual skills to use it are keys to achievement. A recent true story may help to illustrate my point. Laura and her brother, Dave, are in the 9th and 7th grades. This year, Laura was assigned a term paper on the subject of lycra, a synthetic fabric used in fashion design. Dave was assigned a science paper on the subject of the black-footed ferret, a nearly extinct animal. Their father works for Mead Data Central, the company that provides NEXIS and LEXIS services. NEXIS provides, on line, the full text of news magazines, The Washington Post, Associated Press, and other news services. LEXIS provides the same kind of service for legal information. Laura keyed in "LYCRA" on the NEXIS system, and retrieved four recent AP stories from Paris about fashions, how to handle the material, how it's made. It took her about a half hour to retrieve the information and write the paper, including full citations. Dave keyed in BLACK FOOTED FERRET on the LEXIS system, and got full text of recent judicial decisions relating to habitat, status, and protection of this endangered species. His paper, too, contained complete citations to recent, relevant literature. Needless to say, both children got A pluses on their papers.

Our society is evolving so rapidly into an information-based world that different people have very different perceptions of the needs for computer literacy. A strategy for addressing computer literacy in school curricula must take into account this diversity of perceptions on the part of parents, school board members, administrators, staff, teachers, and students.

Discontinuity of Educational Needs

The shift to an information-based economy has produced what Andrew Molnar has termed a "discontinuity" in educational needs (Molnar, 1978). A list of over 400 course goals in computer education for grades K-12 produced by the Tri-County Task Force in Multnomah County, Oregon (1979) illustrates this point. If one assumes that teachers and students are not in the future going to spend more time and energy in learning and teaching than they presently do, then new goals must replace or modify old ones. This will require reordering priorities in math, science, and social studies curricula.

At the same time, the need for computer literacy is only one of myriad pressures on the schools for curriculum change. Career awareness, minimal competencies, back-to-basics, life-role skills, ecology and environment, energy, and equity for women and minorities are some of the other concerns. Computer uses should support, rather than compete with, these other goals and priorities.

Approaches to Satisfying Needs for Computer Literacy

In a study we conducted a couple years ago, we found schools and school districts around the country trying a variety of approaches in order to satisfy needs for computer literacy (Hunter and Hargan, 1979). Some of these approaches are summarized in Figures 2 and 3. They focus on various dimensions of the problem—teacher training, equipment, curriculum development—and emphasize one or more of the subject areas listed earlier. These approaches have had varying degrees of success as measured by the proportion of students and teachers reached, stability of the programs, and learning outcomes achieved. Most of these approaches lacked systematic integration of a developmental sequence of learning outcomes into the existing curriculum, but establish a local base of support and expertise upon which to build.

District Plan for Instructional Computing

Required Literacy Course – Junior High

Literacy Units in Math Classes – Junior High

Elective Computer Courses

Study Units in Other Courses

Computer Clubs

Community Involvement

Equipment Availability

Teacher Training

Figure 2. **Strategy Examples**

School/District	Target
Richardson ISD Texas	All 8th Grades; Interested High School Students
San Jose USD California	Junior High
Huntington Beach USD California	Board of Trustees; Administrators; Faculty and Staff; Interested Students
Highline SD Washington	All Students
A.I. duPont SD Delaware	8th Grade Math
Teaneck HS New Jersey	All Students and Teachers
Maple Lake HS Minnesota	All 8th Graders; Teachers; Most Other Students
Sehome HS Washington	Motivated High School Students
Riverdale Country School New York	All 8th & 10th Graders; Teachers; Most Other Students

Figure 3. **Targets for Computer Literacy Programs**

K-8 Infusion Approach

The approach we are developing establishes a process for infusing computer literacy objectives into the existing curriculum, using whatever materials and equipment are available. This idea was suggested to me by Kay Morgan, who had seen the need at Montgomery County Public Schools for a more systematic integration of computer literacy into the curriculum. Part of this idea is represented schematically in Figure 4. It appears that the overlap between existing curricula, computer literacy goals, and available resources is at present quite small. This is why I suggest a modesty of aims in the short run. However, I think in the long run this strategy will have the most productive results. While only a few of the possible computer literacy goals will be addressed initially, these goals most directly support existing curriculum goals in math, social studies, and science. At Montgomery County Public Schools, the school board members, administrators, staff, and teachers have repeatedly made the point that the computer literacy goals and activities must support existing curricula. As classroom computing experience is gained by more and more teachers and students, integration of more computer-related goals will become easier. It is to be hoped that this effort will in turn stimulate developers and publishers to provide more classroom materials and computer programs to support these educational goals.

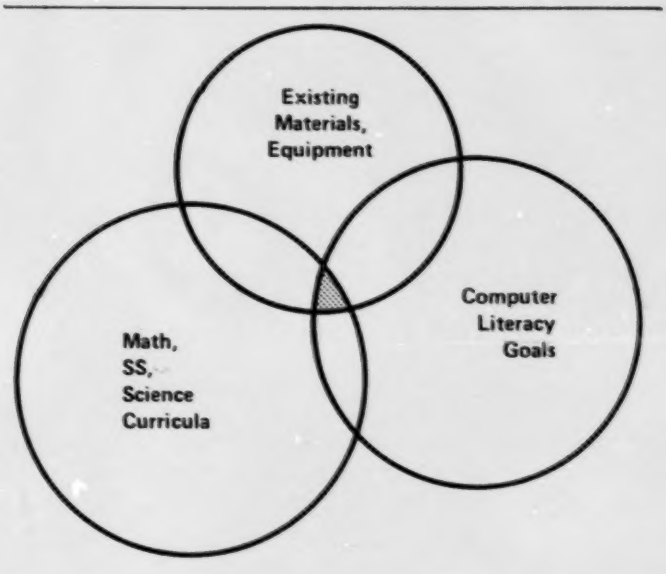

Figure 4. **Modesty of Aims**

Curricula Guide for K-8 Computer Literacy

In mid-April of 1980, we at HumRRO joined with Montgomery County Public Schools and educators across the country to develop a guide on computer literacy for grades K-8. This project is supported by a grant from the National Science Foundation's program, Development in Science Education (DISE). In this project, we will produce a series of guides for use by school administrators, media center people, teachers for grades K-8, and

subject coordinators. The guides will include statements of learning outcomes, targeted toward: grade levels; math, social studies and science subject areas; and topics. Along with each outcome/grade level/subject area, will be suggestions for classroom activities and learning resources to support the objective. Teacher training guidance will also be included.

Major Activities

Figure 5 lists the major activities involved. A group of about sixteen people from around the country participated in an effort to define a minimal set of learning outcomes in computer literacy. These are people who have thought about and worked with children and computers from various perspectives—math, social studies, or science education; teacher training; curricular materials development; program implementation in schools; educational research.

Major Activities	Who?
Define about 40 learning outcomes	National Panel of Experts
Search for learning materials and activities	HumRRO; Publishers; Vendors; Clearinghouses
Place outcomes into grade levels, subject areas, topics	MCPS Educational Specialists and teachers
Suggest activities, materials	HumRRO; suppliers
Train teachers—Pilot Schools	HumRRO; MCPS
Try Out and Evaluate	HumRRO; MCPS; other field test sites
Revise and Produce Guides	HumRRO; suppliers
Disseminate	Publisher
(National Field Tests)	

Figure 5. **Major Activities in the Project**

Guided by a list of learning outcomes agreed upon by the panel of experts, we are searching for existing computer programs, films, books, magazine articles, and other materials or activities that might be used to learn and teach these subjects. We are looking especially for activities that would support both a computer literacy objective and objectives in the traditional curricula. In this activity, we are highly dependent upon efforts of clearinghouses, resource centers, catalogers, publishers, and vendors.

Learning outcomes are being submitted to a curriculum jury in Montgomery County Public Schools. This jury includes about twenty curriculum specialists for K-8 math, science, and social studies, and about twenty-five K-8 teachers and school principles who have had experience in classroom uses of computers. Through an iterative series of

questionnaires, the jury is placing the outcomes into appropriate grade levels, subject areas, and topics. The outcome of this activity will be a sequence of objectives, by grade level, course (math, social studies, or science), and topic. Our curriculum jury will not be able to find an appropriate place in the existing curriculum for all computer literacy outcomes. Thus, we may supplement the infusion strategy with a mini-course that addresses these extra computer literacy goals.

For each computer literacy outcome, at each grade level, course, and topic, one or more classroom activities will be suggested. In as many cases as possible, we suggest activities that do not require access to equipment as well as activities that do require access. We are suggesting materials and activities that are available from the most reliable suppliers. We do not in this project have the resources to evaluate or improve these materials or to develop new materials.

After we have organized this and other information into a curriculum kit or guide, we will try it out in pilot schools at Montgomery County. This tryout includes a limited amount of teacher training. One outcome of this activity will be guidance on the amount and type of teacher training that is essential, and how to provide it.

To test the generalizability of our methods and content, tryouts will be conducted in at least two other school districts in addition to Montgomery County. Later, there should be a broader field test nationally.

We intend for the guide to be disseminated by an established publisher of educational materials, and are discussing this with a number of candidate publishers.

Pros and Cons of Infusion Approach

The infusion approach as we have described it appears to have both advantages and disadvantages as compared with some other approaches that are being tried. Some of the apparent advantages are:

- Universal Computer Literacy
- Minimization of Teacher Load
- Minimization of Teacher Training Required
- Developmental Sequence
- Continuity for Educators
- Content-Context
- Relevance to Students' Work

By choosing the K-8 grade range, we are directly addressing universal computer literacy and the need for equity in educational opportunity. By choosing just a minimal set of objectives and spreading them out over the grades and subject areas, we minimize the load on individual teachers and the amount of teacher training required. Also, in this way we begin to address the issues of sequencing computer literacy skills and knowledge in a way that takes child development into account.

To me, the most compelling argument for the infusion approach, as opposed to trying to add computer literacy courses, has to do with the real substance of computer literacy. The whole point of computers in our information-based society is to provide us with the tools we need to solve problems, to augment our intellects, and to give us relevant information when we need it. For a young student, this means tools to use in learning and doing math, science, social studies, and whatever else he/she is learning. The infusion approach attempts to provide these tools in a manner and context that is clearly relevant to the students' work.

Finally, as indicated earlier, different people have different perceptions of the need for computer literacy; there are some people who do not perceive these needs and are opposed to this intrusion on the basic curriculum. By providing support to the existing curriculum, we help to bridge the gap between the past and the future.

Some limitations and problems with infusion, at least in the way we are going about it, are:

- Need strong commitment from Board and Administration of school district
- Require participation of many people, and literacy on their part
- Need teacher training
- Need activities and materials to support objectives
- Equipment scheduling more complex
- Need hooks into existing curriculum
- Also need infusion in language arts, humanities
- Don't yet have sequence based on developmental stages

A school district must have a strong commitment from the Board of Education and the administration in order to provide the policies and resources needed to establish goals and implement systematic curriculum change. Studies we have made of the history of computer use for instruction in schools around the country suggest that such commitment takes many years to build. Related to this is the fact that infusion requires participation of many people in a school district and a basic level of computer literacy on the part of curriculum specialists and teachers. Even in relatively computer-advantaged school districts, many social studies, math, and science curriculum specialists have not yet achieved that level of literacy themselves.

Our project does not directly address the tremendous teacher training problem caused by the computer revolution. Some have suggested that one approach would be to concentrate all possible resources on teacher training for the next few years and then make the infusion effort. I think we need both strategies.

The infusion approach is highly dependent upon the existence of classroom activities and learning materials to support both computer literacy goals and existing curriculum goals. While such resources are presently limited and of uneven quality, I believe that our guides (as well as other factors) will stimulate development of appropriate materials. A related problem has to do with computer equipment. The infusion approach will involve more complex scheduling of equipment, to make it available to many different groups of students, than would an approach that involved a special computer literacy course. Further, a large school district may find it difficult to provide equal access to equipment among the many schools in the district.

Another problem alluded to earlier is that of finding "hooks" into the existing curriculum. The fundamentals of computer programming, for example, are probably best learned as the focus of study and not as part of math, science or social studies.

Our project does not address language arts and humanities curricula, but these are also important areas for infusion of computer literacy.

Another limitation at present is the lack of research on which to base a sequence on hierarchy of skills and concepts to be learned. Much research needs to be done in areas of cognitive development and individual differences with respect to the acquisition of information-handling skills and knowledge, before educators can with confidence decide the appropriate grade levels for introduction of these ideas and activities.

Conclusion

Skills, knowledge, and values related to computers and information systems must be integrated into the education of all citizens. Our approach is to provide guidance on high-priority learning outcomes in computer literacy and to fit these outcomes into the existing math, science and social studies curricula in grades K-8. Some of the resources needed to fully implement this approach are now lacking in most school districts. Therefore, a modesty of aims is called for. However, we hope to facilitate the process by providing a map that shows how to travel from existing roads into the new territory.

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